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Kondo et al.

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(54) **CONNECTOR AND CONTACT**

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(51) **Int. Cl.**

H01R 4/66	(2006.01)
H01R 12/79	(2011.01)
H01R 12/52	(2011.01)
H01R 13/03	(2006.01)
H01R 13/6473	(2011.01)
H01R 12/77	(2011.01)

(Continued)

(52) **U.S. Cl.**

CPC ***H01R 12/79*** (2013.01); ***H01R 12/52*** (2013.01); ***H01R 12/775*** (2013.01); ***H01R 13/035*** (2013.01); ***H01R 13/6473*** (2013.01); *H01R 13/6585* (2013.01); *H05K 1/05* (2013.01); *H05K 1/117* (2013.01); *H05K 2201/09172* (2013.01)

(58) **Field of Classification Search**

CPC H01R 12/52; H01R 12/79; H01R 12/775; H01R 13/03; H01R 13/035; H01R 13/6473; H01R 13/6585; H01R 13/65805; H01R 9/07; H01R 9/0714; H01R 12/73; H01R 12/737; H01R 13/652; H05K 2201/09172; H05K 1/117; H05K 1/05

USPC 439/733.1, 67–73, 77, 591, 637, 886, 439/931, 942, 108; 361/748, 749, 760

See application file for complete search history.

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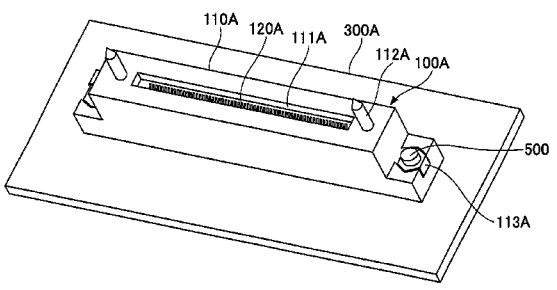
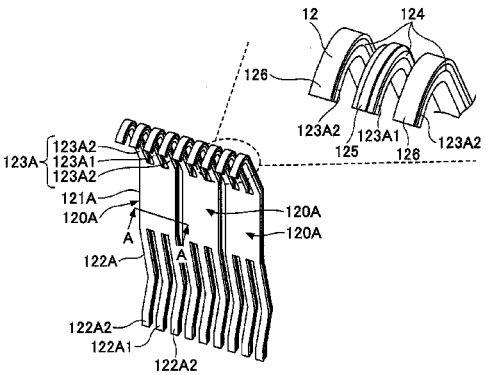
(57) **ABSTRACT**

A connector includes a terminal including a base, first extension parts that extend from the base toward a first end of the connector and second extension parts that extend from the base toward a second end of the connector; an insulating layer formed on the terminal; a signal line that is formed on the insulating layer and extends from an end of one of the first extension parts to an end of one of the second extension parts, the signal line being connected to a signal wire of a board; and a ground line that is formed on the insulating layer, is electrically connected to the terminal, and extends from an end of another one of the first extension parts to an end of another one of the second extension parts, the ground line being connected to a ground wire of the board.

7 Claims, 13 Drawing Sheets





(51) **Int. Cl.**

H01R 13/6585	(2011.01)
H05K 1/05	(2006.01)
H05K 1/11	(2006.01)

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FIG.1A

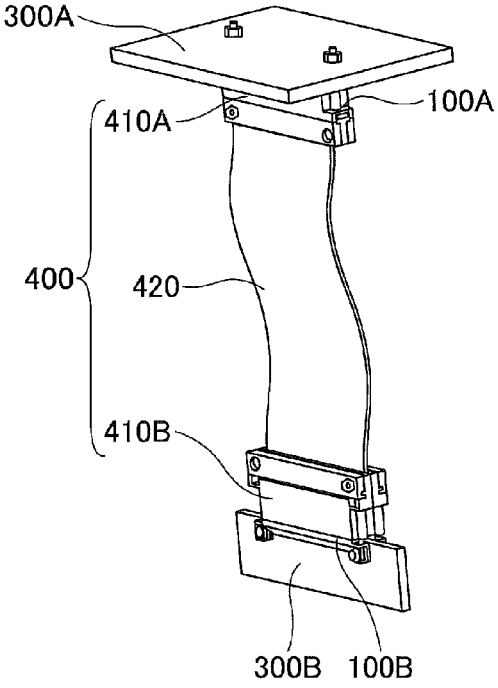

300A
410A
100A
400
420
410B
300B
100B

FIG.1B

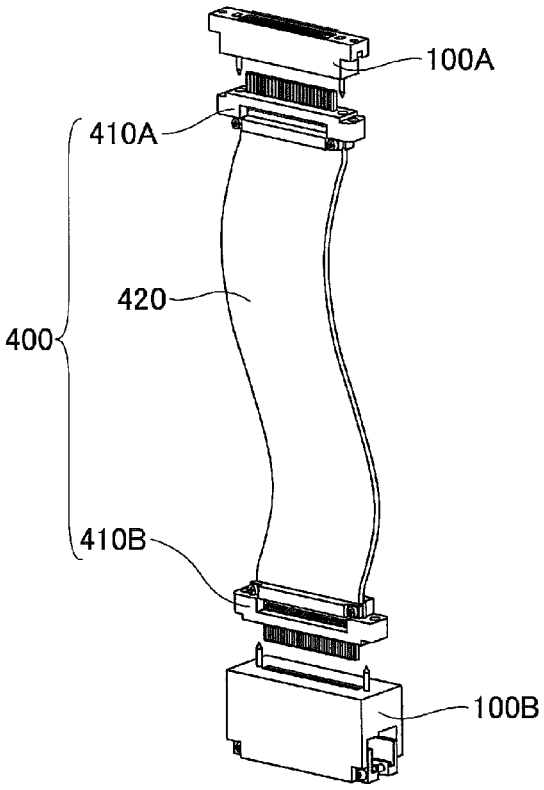

100A
410A
420
400
410B
100B

FIG.2A

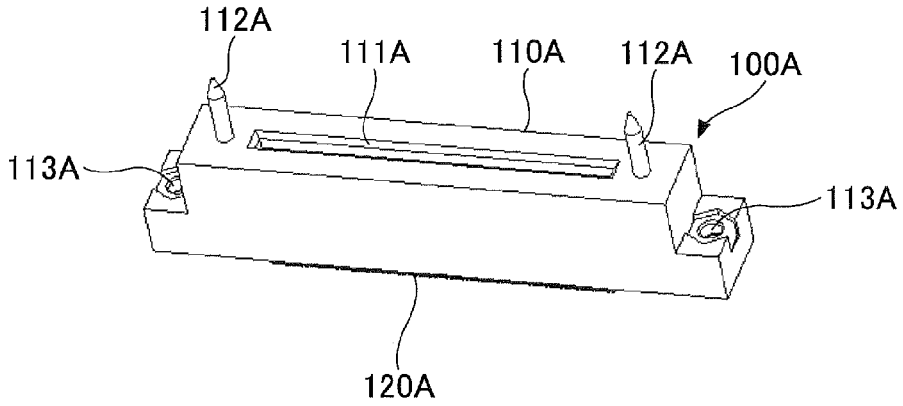


FIG.2B

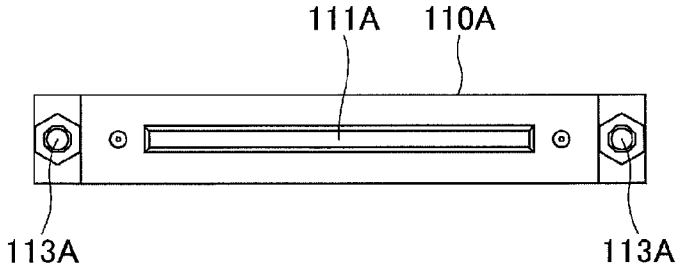


FIG.2C

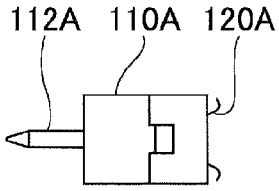


FIG.2D

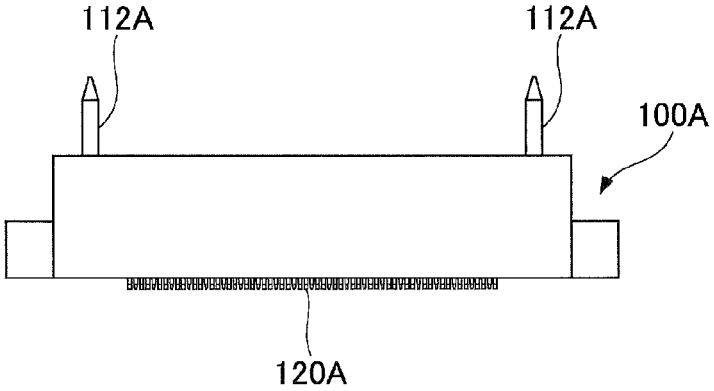


FIG.3

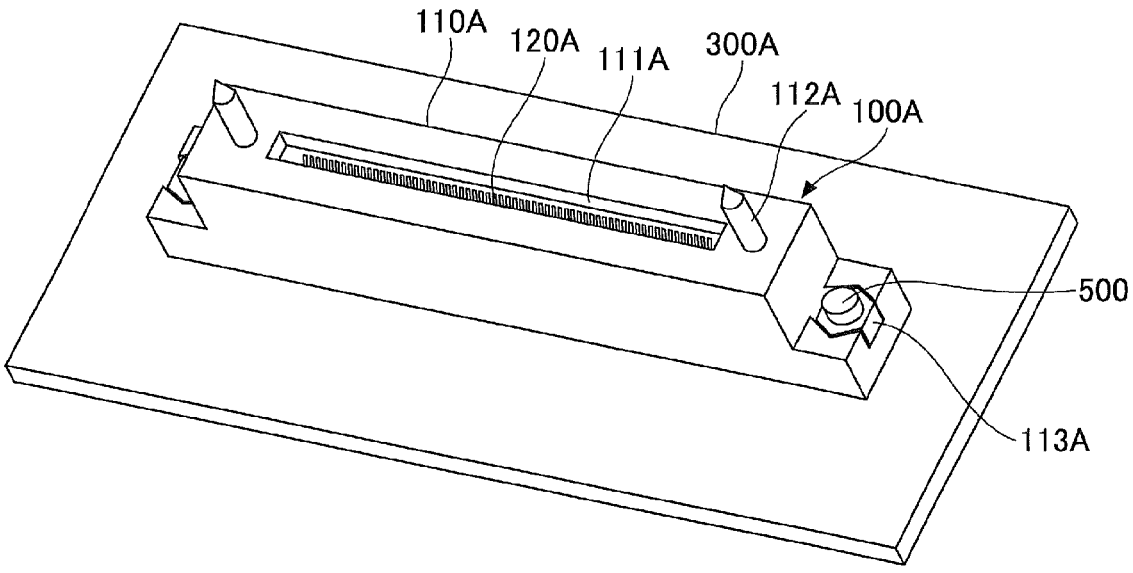


FIG.4A

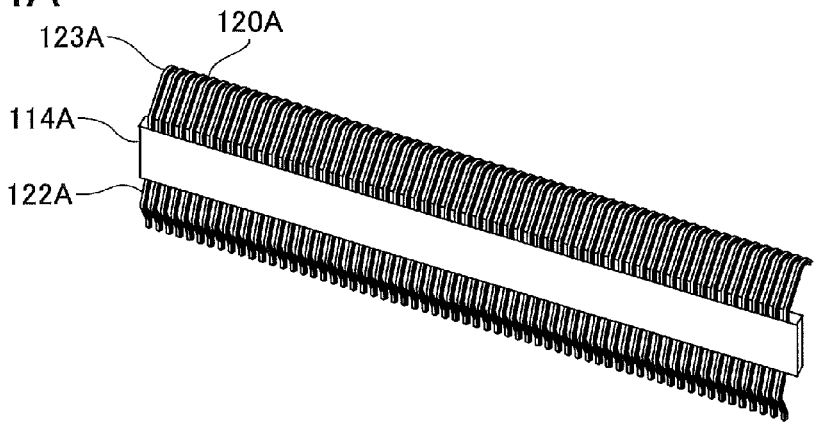


FIG.4B

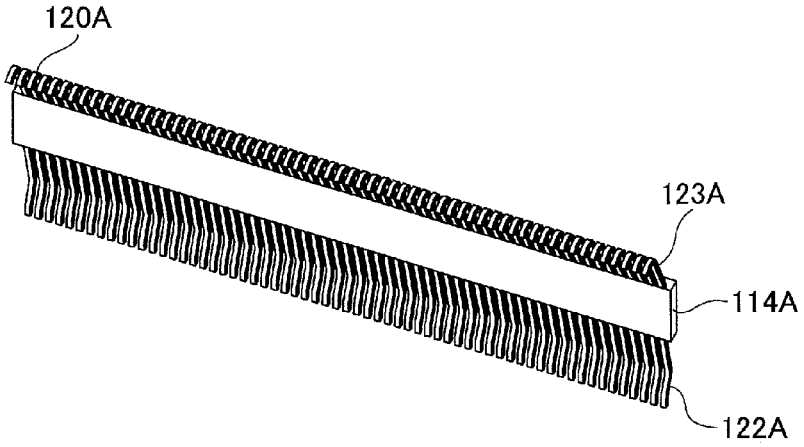


FIG.4C

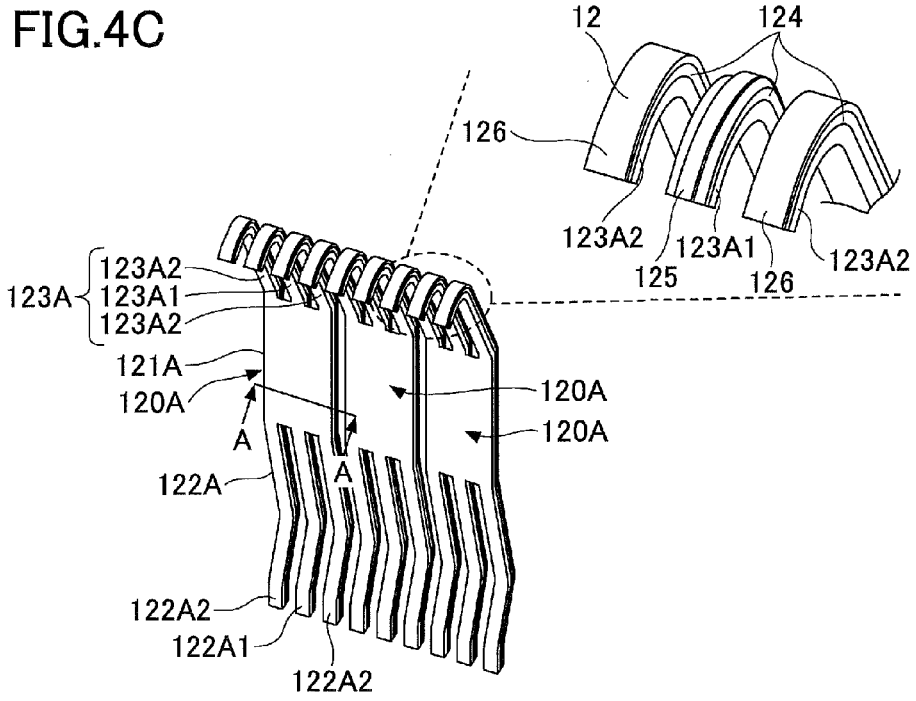


FIG.5A

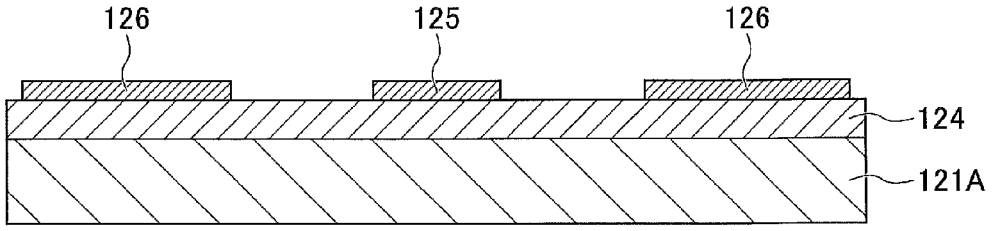


FIG.5B

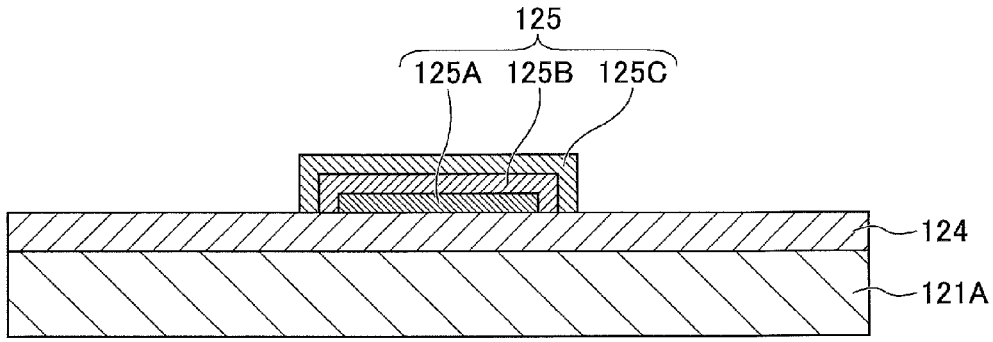
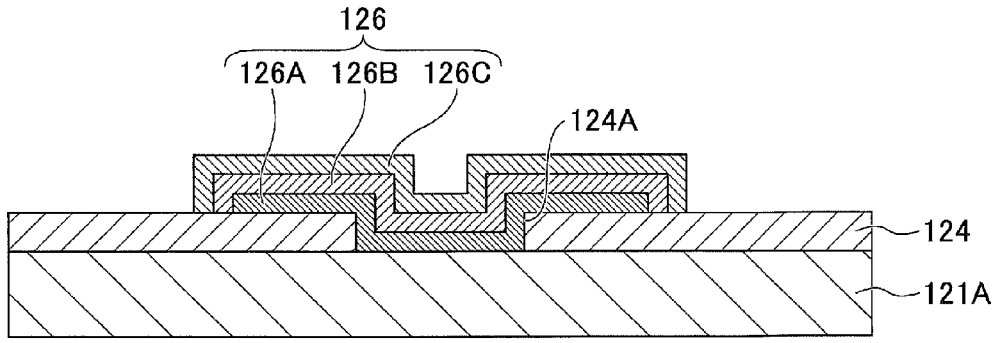


FIG.5C



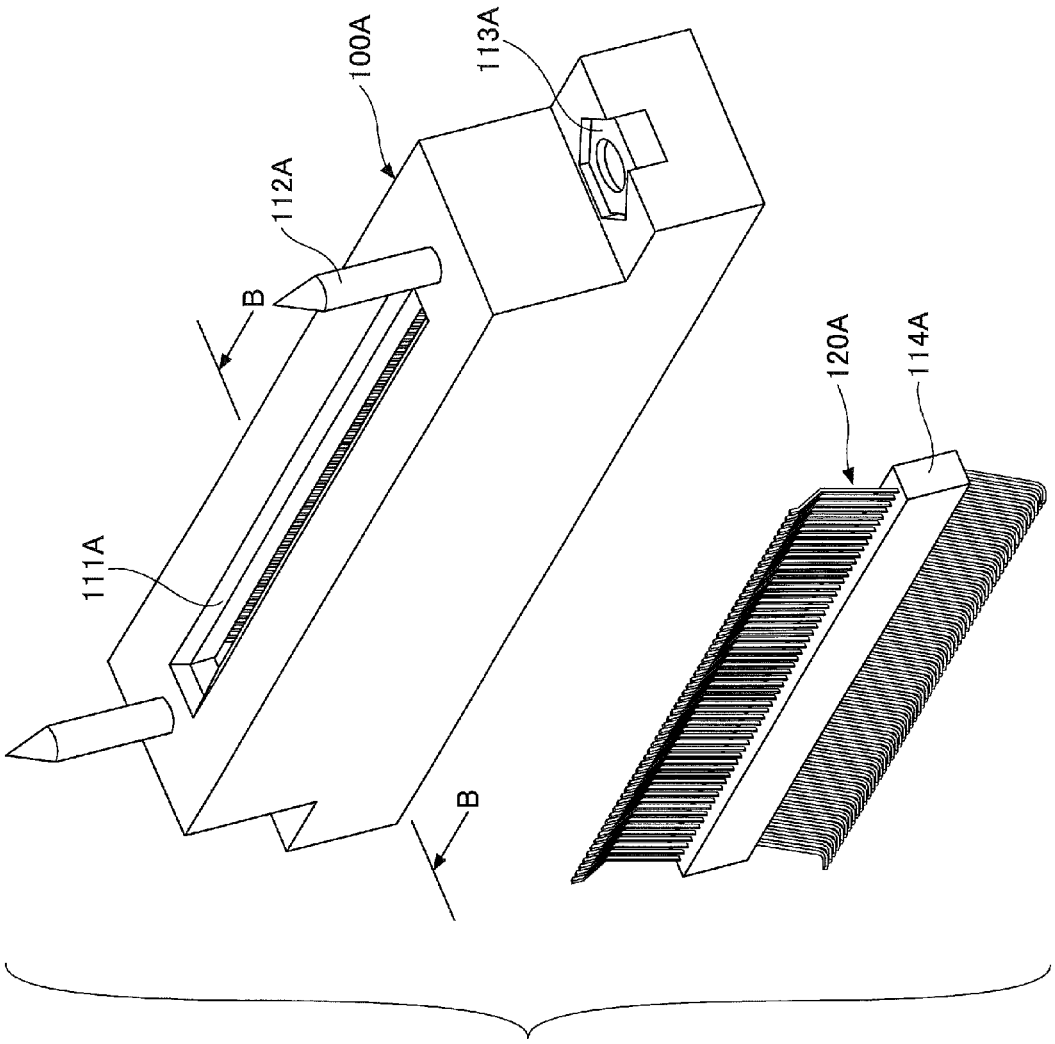


FIG.6

FIG.7

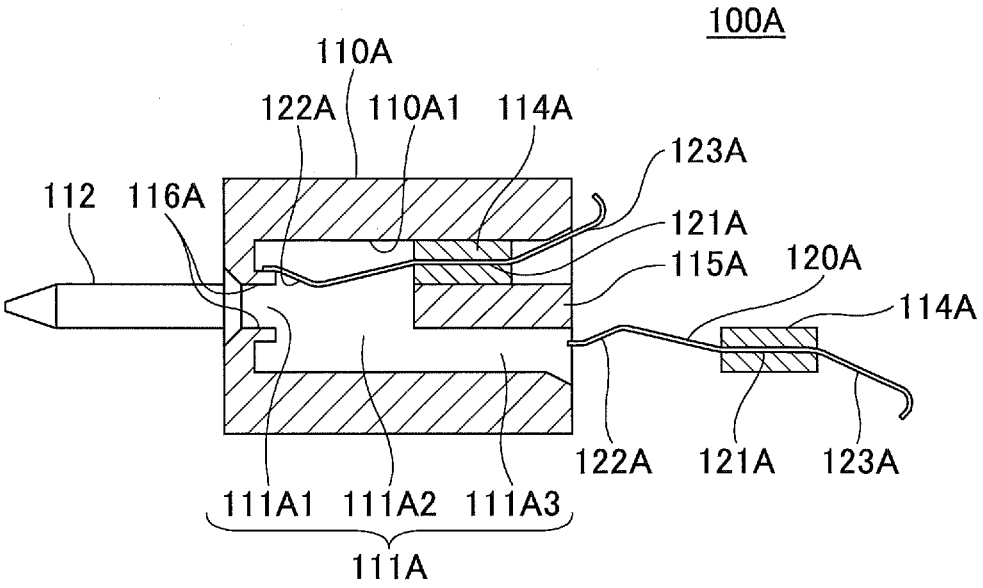

100A
110A
122A
110A1
114A
123A
112
116A
121A
115A
120A
114A
122A
121A
123A
111A1
111A2
111A3
111A

FIG.8A

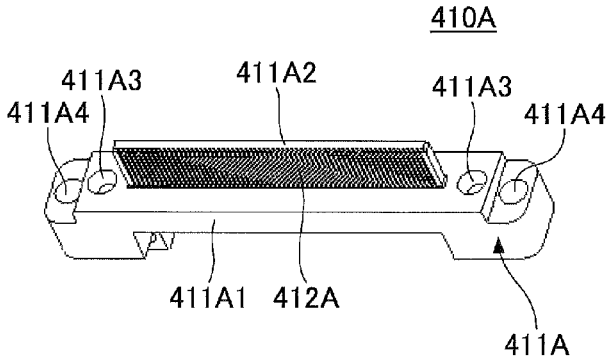


FIG.8B

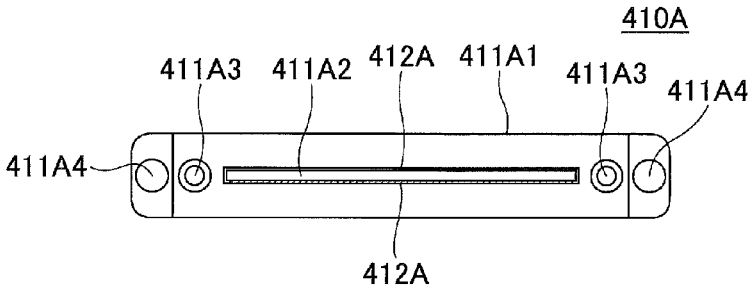


FIG.8C

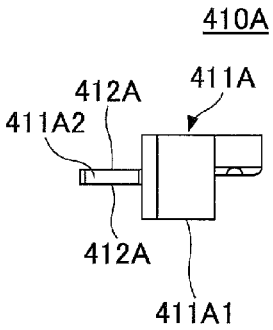


FIG.8D

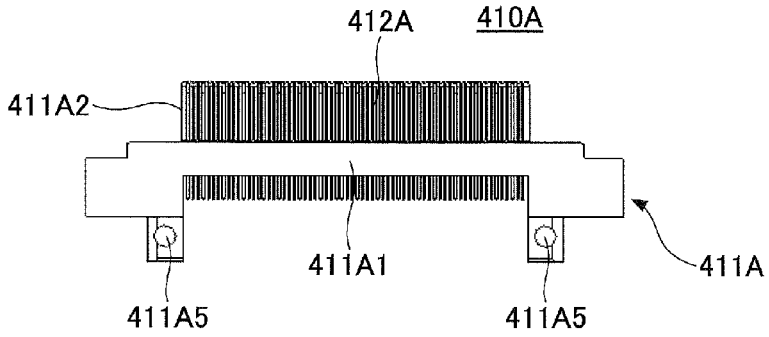
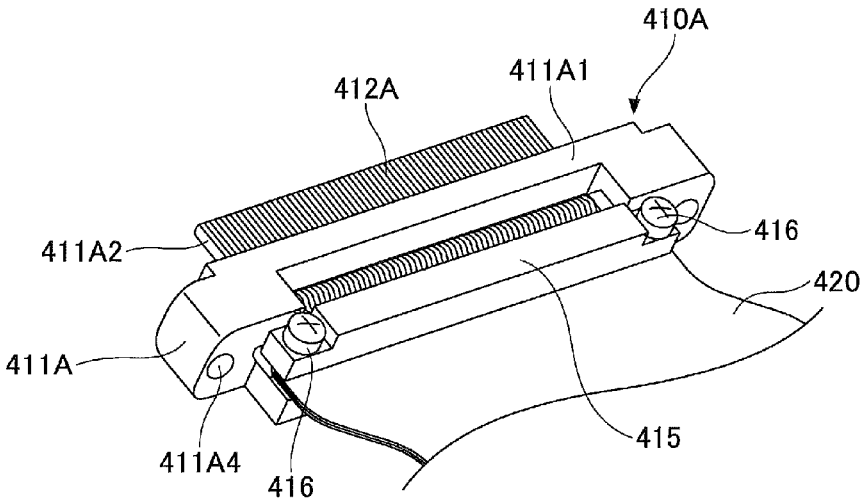


FIG.9A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411A1
412A
416
411A2
420
411A
415
411A4
416

FIG.9B

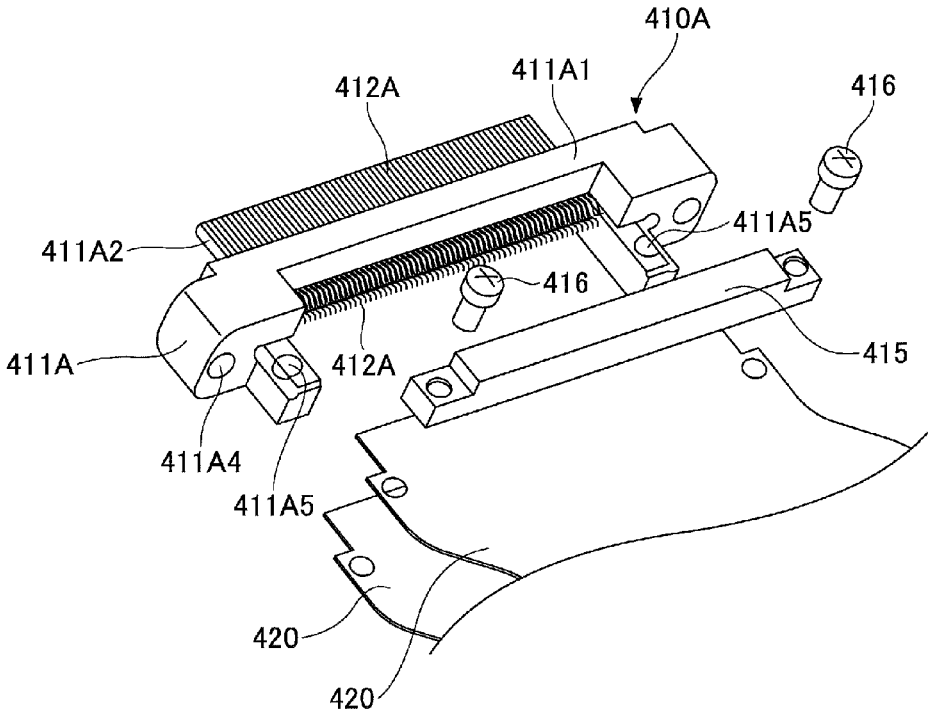

410A
411A1
412A
416
411A5
411A2
416
411A
412A
415
411A4
411A5
420
420

FIG.10

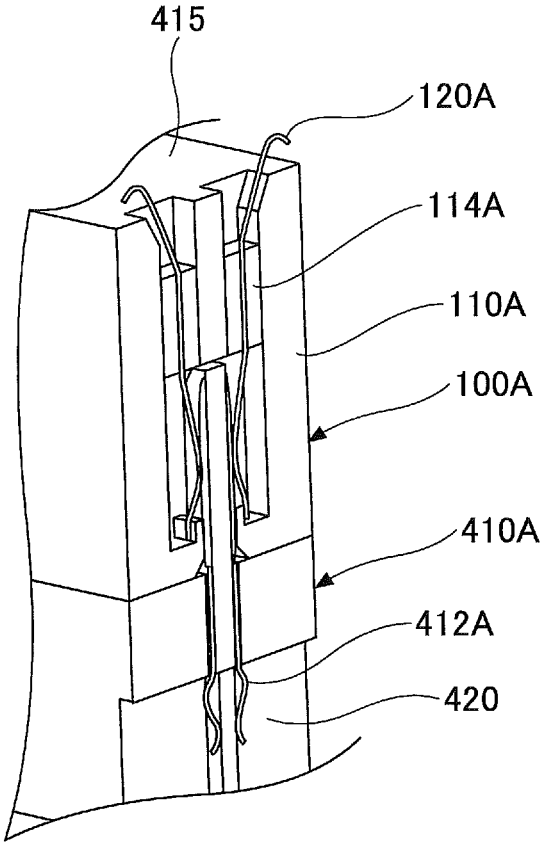


FIG.11A

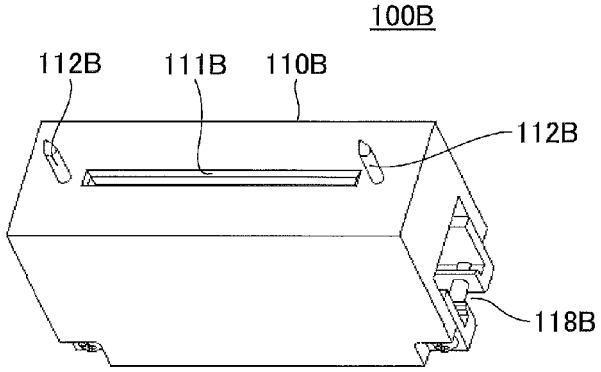
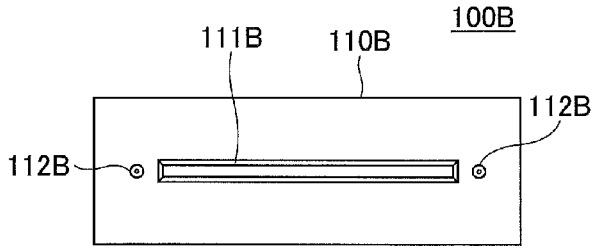


FIG.11B



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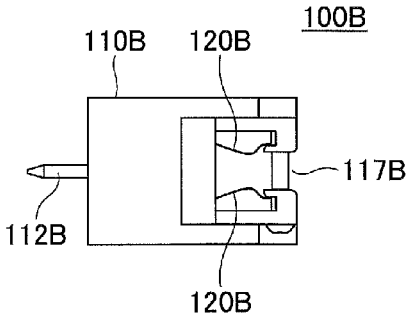

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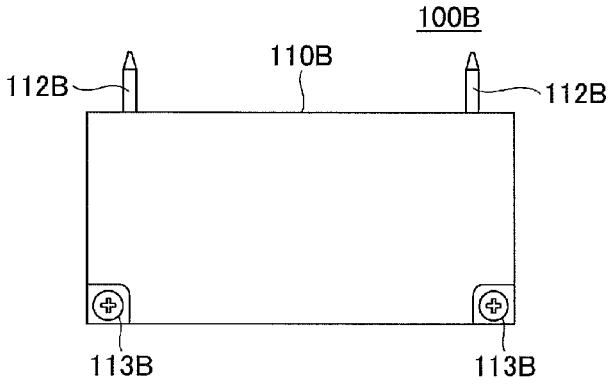


FIG.12

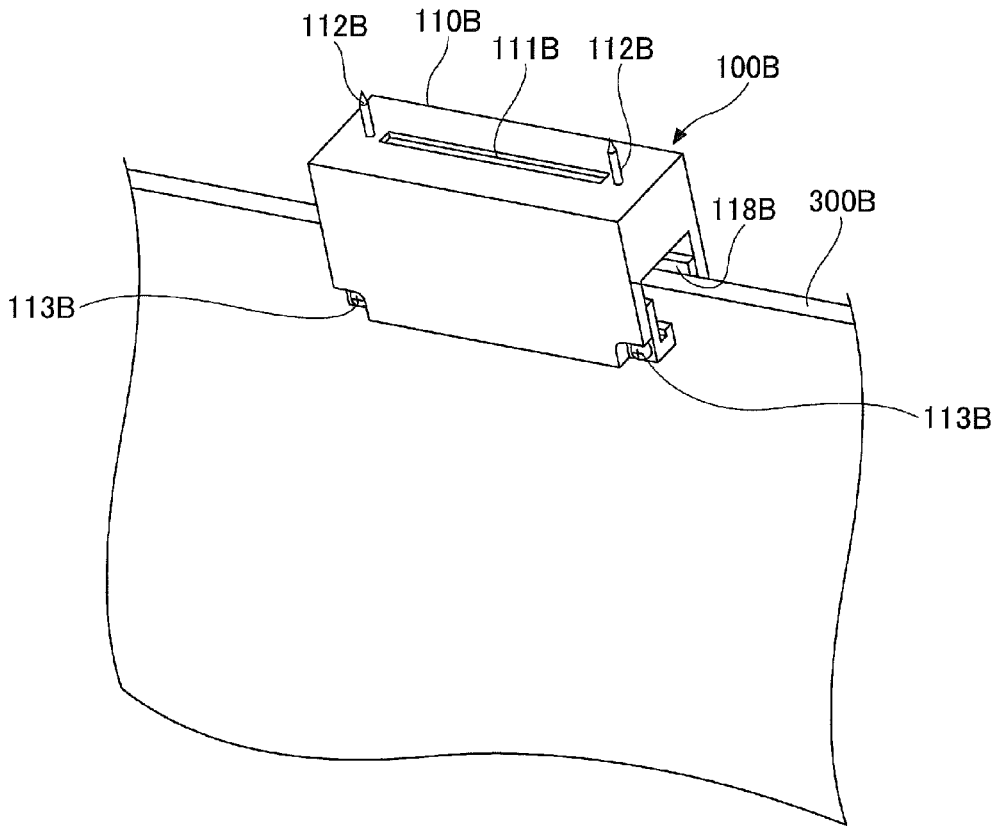
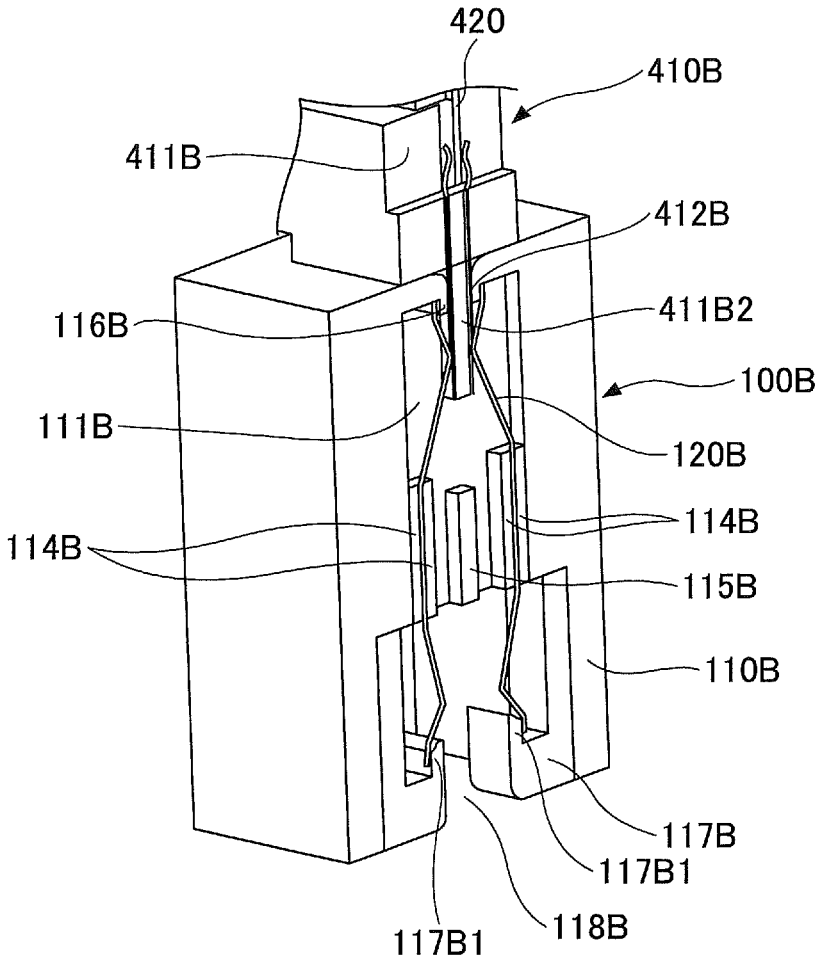


FIG.13


420
410B
411B
412B
411B2
116B
100B
111B
120B
114B
114B
115B
110B
117B
117B1
118B
117B1

CONNECTOR AND CONTACT

CROSS-REFERENCE TO RELATED APPLICATION

The present application is based upon and claims the benefit of priority of Japanese Patent Application No. 2014-090556, filed on Apr. 24, 2014, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

An aspect of this disclosure relates to a connector and a contact.

2. Description of the Related Art

Japanese Laid-Open Patent Publication No. 2003-142183, for example, discloses a contact module that includes a sheet made of a metal, an insulating film formed on at least one surface of the sheet, and a contact formed as a thin film of a noble metal on the insulating film and including contact points and a circuit pattern.

However, in the disclosed contact module, the impedance of the sheet made of a metal is not matched sufficiently with the impedance of the contact formed on the insulating film on the sheet. Therefore, with the disclosed contact module, it may be difficult to transmit a signal in an impedance matched condition.

SUMMARY OF THE INVENTION

An object of the invention is to provide a connector and a contact that may transmit signal in an impedance matched condition. In an aspect of the invention, there is provided a connector to be connected to a signal wire and a ground wire formed on a board. The connector includes a base made of a conductive material, at least two first extension parts that extend from the base toward a first end of the connector, and at least two second extension parts that extend from the base toward a second end of the connector; an insulating layer formed on a surface of the terminal; a signal line that is formed on the insulating layer, is insulated from the terminal, and extends from an end of a first one of the first extension parts to an end of a first one of the second extension parts, the signal line being connected to the signal wire of the board when the connector is attached to the board; and a ground line that is formed on the insulating layer, is electrically connected to the terminal, and extends from an end of a second one of the first extension parts, which is adjacent to the first one of the first extension parts, to an end of a second one of the second extension parts, which is adjacent to the first one of the second extension parts, the ground line being connected to the ground wire of the board when the connector is attached to the board.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**A and **1**B are drawings illustrating connectors;

FIGS. **2**A through **2**D are drawings illustrating a connector;

FIG. **3** is a perspective view of a connector attached to a board;

FIGS. **4**A through **4**C are drawings illustrating contacts;

FIGS. **5**A through **5**C are cross-sectional views taken along line A-A of FIG. **4**C;

FIG. **6** is a drawing illustrating a connector;

FIG. **7** is a drawing illustrating a connector;

FIGS. **8**A through **8**D are drawings illustrating a connector of an FPC assembly;

FIGS. **9**A and **9**B are drawings illustrating a mechanism for attaching a connector to FPCs;

FIG. **10** is a perspective cut-away side view of connectors connected to each other;

FIGS. **11**A through **11**D are drawings illustrating a connector;

FIG. **12** is a perspective view of a connector attached to a board; and

FIG. **13** is a perspective cut-away side view of connectors connected to each other.

DESCRIPTION OF EMBODIMENTS

Embodiments of the present invention are described below with reference to the accompanying drawings.

FIGS. **1**A and **1**B are drawings illustrating connectors **100**A and **100**B according to an embodiment. As illustrated by FIG. **1**A, the connector **100**A is attached to a board **300**A, and the connector **100**B is attached to a board **300**B.

Each of the boards **300**A and **300**B includes signal lines and ground lines. The characteristic impedance of the signal lines and the ground lines of the boards **300**A and **300**B is set at a predetermined value (e.g., 50Ω) to enable high-speed signal transmission at, for example, about 2.0 Gbps.

The signal lines and the ground lines of the boards **300**A and **300**B with such a characteristic impedance may be implemented by microstrip lines or coplanar lines. The connector **100**A is connected to the signal lines and the ground lines of the board **300**A, and the connector **100**B is connected to the signal lines and the ground lines of the board **300**B.

A flexible printed circuit (FPC) assembly **400** includes connectors **410**A and **410**B and two FPCs **420**. Each of the FPCs **420** includes signal lines and ground lines.

The characteristic impedance of the signal lines and the ground lines of the FPCs **420** is set at a predetermined value (e.g., 50Ω) to enable high-speed signal transmission at, for example, about 2.0 Gbps. The connector **410**A is connected to first ends of the FPCs **420**, and the connector **410**B is connected to second ends of the FPCs **420**.

In FIG. **1**B, the connectors **410**A and **410**B of the FPC assembly **400** are connected to the corresponding connectors **100**A and **100**B.

FIG. **2**A is a perspective view, FIG. **2**B is a front view, FIG. **2**C is a side view, and FIG. **2**D is a plan view of the connector **100**A. FIG. **3** is a perspective view of the connector **100**A attached to the board **300**A.

The connector **100**A includes a housing **110**A and contacts **120**A. The connector **100**A is formed by placing the contacts **120**A in a through hole **111**A of the housing **110**A. The housing **110**A includes guide pins **112**A used when the connector **410**A is attached to the connector **100**A. A bottom of each guide pin **112**A is embedded in the body of the housing **110**A. The housing **110**A also includes screw holes **113**A.

Through holes corresponding to the screw holes **113**A are formed in the board **300**A. The screw holes **113** of the housing **110**A are aligned with the through holes of the board **300**A, and the connector **100**A is attached to one surface of the board **300**A with screws **500** inserted into the screw holes **113**A and the through holes of the board **300**A as illustrated by FIG. **1**A and FIG. **3**. For example, the guide pins **112**A may be comprised of a metal such as copper or nickel, or a resin.

The housing **110**A may be comprised of an insulating material such as an epoxy resin. The housing **110**A may have a cuboid shape, and includes protrusions protruding in the

longitudinal direction of the housing **110**A. The screw holes **113**A are formed in the protrusions of the housing **110**A.

Each contact **120**A includes a first end and a second end, and extends in a direction that is substantially perpendicular to a surface of the board **300**A. The second end of the contact **120**A to be connected to the board **300**A is illustrated in FIGS. **2**A, **2**C, and **2**D, and the first end of the contact **120**A is illustrated in FIG. **3**. The first end of the contact **120**A is connected to the connector **410**A of the FPC assembly **400**, and the second end of the contact **120**A is connected to the signal line and the ground lines of the board **300**A.

FIGS. **4**A and **4**B are perspective views and FIG. **4**C is an enlarged view of the contact **120**A. FIG. **5**A is a cross-sectional view taken along line A-A of FIG. **4**C, and FIGS. **5**B and **5**C are enlarged views of parts of FIG. **5**A.

The contact **120**A is a linear leaf spring. As illustrated by FIGS. **4**A and **4**B, twenty-two contacts **120**A are bound together with a holder **114**A. Each contact **120**A includes leaf spring structures that protrude from the holder **114**A in opposite directions. The holder **114**A is a part of the housing **110**A (see FIGS. **2**A-**2**D and FIG. **3**), and is disposed inside of the housing **110**A. The internal configuration of the housing **110**A is described later with reference to FIG. **7**.

FIG. **4**C illustrates contacts **120**A arranged adjacent to each other. FIG. **4**C also includes an enlarged view of an end portion of one of the contacts **120**A.

The contacts **120**A bound together with the holder **114**A as illustrated by FIGS. **4**A and **4**B are arranged as illustrated by FIG. **4**C. In FIG. **4**C, three of the twenty-two contacts **120**A are illustrated as an example, and the holder **114**A is omitted.

Each contact **120**A includes a base **121**A, extension parts **122**A, extension parts **123**A, an insulating layer **124**, a signal line **125**, and two ground lines **126**.

The base **121**A, the extension part **122**A, and the extension part **123**A are formed integrally as a single component that is an example of a ground terminal. The base **121**A, the extension part **122**A, and the extension part **123**A may be formed, for example, by punching sheet metal made of, for example, stainless steel and bending the punched sheet metal.

The insulating layer **124**, the signal line **125**, and the ground lines **126** are formed on the ground terminal, that is, on the base **121**A, the extension part **122**A, and the extension part **123**A.

The base **121**A is a plate-like part. The extension parts **122**A and **123**A extend from the corresponding ends of the base **121**A in the length direction. The insulating layer **124** is formed on one surface of the base **121**A, and the signal line **125** and the ground lines **126** are formed on the insulating layer **124**.

The extension part **122**A extends from one end (the lower end in FIG. **4**C) of the base **121**A and branches into three extension parts, one extension part **122**A**1** in the middle and two extension parts **122**A**2** provided on the sides of the extension part **122**A**1**.

On the extension part **122**A**1**, the signal line **125** is formed on the insulating layer **124**. On the extension parts **122**A**2**, the ground lines **126** are formed on the insulating layer **124**. The signal line **125** and the ground lines **126** formed on the extension part **122**A are connected to the signal line **125** and the ground lines **126** formed on the base **121**A.

In FIG. **4**C, although the insulating layer **124**, the signal line **125**, and the ground lines **126** formed on the back side of the extension part **122**A are not visible, their configurations are substantially the same as those of the insulating layer **124**, the signal line **125**, and the ground lines **125** formed on the extension part **123**A.

The signal line **125** and the ground lines **126** formed on the extension part **122**A are to be connected to the connector **410**A (see FIGS. **1**A and **1**B).

As illustrated by FIGS. **4**A and **4**B, two sets of the contacts **120**A are used in the present embodiment. A conductive part of the connector **410**A is inserted between the signal lines **125** and the ground lines **126** of the extension parts **122**A of a first set of the contacts **120**A and the signal lines **125** and the ground lines **126** of the extension parts **122**A of a second set of the contacts **120**A, and the connector **100**A and the connector **410**A are electrically connected to each other. To be able to sandwich the conductive part of the connector **410**A between pairs of the contacts **120**A, the extension part **122**A has a leaf spring structure. The leaf spring structure of the extension part **122**A is configured such that an elastic force acts in such a direction that a distance between a pair of opposing extension parts **122**A is reduced.

The extension part **123**A extends from another end (the upper end in FIG. **4**C) of the base **121**A and branches into three extension parts, an extension part **123**A**1** in the middle and two extension parts **123**A**2** on the sides of the extension part **123**A**1**.

On the extension part **123**A**1**, the signal line **125** is formed on the insulating layer **124**. On the extension parts **123**A**2**, the ground lines **126** are formed on the insulating layer **124**. The signal line **125** and the ground lines **126** formed on the extension part **123**A are connected to the signal line **125** and the ground lines **126** formed on the extension part **122**A via the signal line **125** and the ground lines **126** formed on the base **121**A.

The signal line **125** and the ground lines **126** formed on the extension part **123**A are to be connected to the corresponding signal line and ground lines on the board **300**A.

The extension part **123**A has a leaf spring structure whose end portion has a curved shape. When the curved end portion is pressed toward the base **121**A, the extension part **123**A elastically bends and a restoring force is generated. This leaf spring structure enables reliable electrical connection between the end of the extension part **123**A and the signal line and the ground lines of the board **300**A.

FIG. **5**A illustrates the insulating layer **124**, the signal line **125**, and the ground lines **126** formed on one surface of the base **121**A. As described above, the insulating layer **124** is formed on the base **121**A, the extension part **122**A, and the extension part **123**A. Also, the signal line **125** and the ground lines **126** are formed continuously on the base **121**A, the extension part **122**A, and the extension part **123**A via the insulating layer **124**.

FIG. **5**A illustrates a cross section of the base **121**A on which the insulating layer **124**, the signal line **125**, and the ground lines **126** are formed. A cross section of each of the extension part **122**A and the extension part **123**A may be obtained by dividing the cross section of FIG. **5**A into three sections in the horizontal direction.

The insulating layer **124** may be implemented by, for example, a polyimide film. The insulating layer **124** is pasted onto the base **121**A, the extension part **122**A, and the extension part **123**A.

As illustrated by FIG. **5**B, the signal line **125** includes a Cu plated layer **125**A, an Ni plated layer **125**B, and an Au plated layer **125**C. The signal line **125** may be formed on the insulating layer **124** by a plating process.

As illustrated by FIG. **5**C, a groove **124**A is formed in a part of the insulating layer **124** below the ground line **126**. The groove **124**A passes through the insulating layer **124** in the thickness direction, and extends from one end to the other end of the ground line **126** in the length direction.

The ground line **126** includes a Cu plated layer **126**A, an Ni plated layer **126**B, and an Au plated layer **126**C. The ground line **126** may be formed on the insulating layer **124** by a plating process.

Because the Cu plated layer **126** is formed along the groove **124**A, the ground line **126** is physically and electrically connected to the base **121**A, the extension part **122**A, and the extension part **123**A that function as a ground terminal. Accordingly, the ground line **126** is kept at a ground potential.

In the present embodiment, the groove **124**A formed in the insulating layer **124** extends continuously from one end to the other end of the ground line **126**. Alternatively, the groove **124**A may be formed to extend intermittently from one end to the other end of the ground line **126**. Through holes passing through the insulating layer **124** may be formed at predetermined intervals along the ground line **126** instead of the groove **124**A.

Upper parts of the signal line **125** and the ground lines **126** not to be connected to the conductive part of the connector **410**A may be covered with a protective film. The protective film may be implemented by, for example, a polyimide film.

With the above configuration, the base **121**A, the extension part **122**A, and the extension part **123**A of the contact **120**A function as a ground terminal that is kept at a ground potential. Accordingly, the signal line **125**, the base **121**A, the extension part **122**A, and the extension part **123**A form a microstrip line.

The ground lines **126** are formed on the sides of the signal line **125** at the same height as and parallel to the signal line **125**. Accordingly, the signal line **125** and the ground lines **126** form a coplanar line.

The contact **120**A is configured as described above to achieve good impedance matching between the board **300**A and the connector **410**A, to reduce reflection and transmission loss of a signal, and to improve signal transmission characteristics.

With the above configuration, the characteristic impedance of the signal line **125** of the contact **120**A can be set at a predetermined value (e.g., 50Ω).

Next, the housing **110**A of the connector **100**A is described with reference to FIGS. **6** and **7**.

FIGS. **6** and **7** illustrate the connector **100**A. FIG. **7** is a cross-sectional view taken along line B-B of FIG. **6**.

Two sets of twenty-two contacts **120**A bound together with the holder **114**A are placed in the housing **110**A of the connector **100**A. In FIG. **6**, one set of the contacts **120**A is outside of the housing **110**A. The holder **114**A may be implemented as a resin part that is formed by insert molding to hold the bases **121**A of the contacts **120**A together. As another example, the holder **114**A may be implemented as a V-shaped part including two arm parts that are joined at one end. The arm parts are placed to sandwich the bases **121**A of the contacts **120**A, and are then joined at the other end to hold the contacts **120**A together.

As illustrated by FIG. **7**, the through hole **111**A of the housing **110**A includes an opening **111A1**, a middle portion **111A2**, and an opening **111A3**. The opening **111A1** is formed between the guide pins **112**A as indicated by the reference number **111**A in FIG. **6**.

The opening **111A3** is divided into two openings by a partition wall **115**A of the housing **110**A. In FIG. **7**, the holder **114**A of one set of the contacts **120**A is fitted into the upper opening of the opening **111A3**. The gap between an inner wall **110A1** of the housing **110**A and the partition wall **115**A is set at a value that is substantially the same as the thickness of the holder **114**A so that the holder **114**A can be fitted into the gap.

The housing **110**A also includes two engaging parts **116**A at the boundary between the opening **111A1** and the middle portion **111A2**. The engaging parts **116**A are formed to extend along the length direction of the opening **111A1**, and to protrude into the middle portion **111A2**.

When the contacts **120**A bound by the holder **114**A are inserted through the opening **111A3** into the through hole **111**A and the holder **114**A is fitted into the gap between the inner wall **110A1** and the partition wall **115**A, the end of the extension part **122**A of each of the contacts **120**A engages with the corresponding engaging part **116**A.

With the end of the extension part **122**A engaging with the engaging part **116**A and the holder **114**A holding the base **121**A fitted into the gap between the inner wall **110A1** and the partition wall **115**, the extension part **122**A can function as a leaf spring.

In FIG. **7**, the other set of the contacts **120**A is still outside of the housing **110**A. When the other set of the contacts **120**A is also placed in the housing **110**A, the corresponding extension parts **122**A of the two sets of the contacts **120**A face each other, and the signal lines **125** and the ground lines **126** formed on the corresponding extension parts **122**A also face each other. When the conductive part of the connector **410**A is inserted into the connector **100**A through the opening **111A1**, the extension parts **122**A are brought into contact with the conductive part and are elastically bent.

FIG. **8**A is a perspective view, FIG. **8**B is a front view, FIG. **8**C is a side view, and FIG. **8**D is a plan view of the connector **410**A of the FPC assembly **400** to which the connector **100**A is to be connected.

The connector **410**A includes a housing **411**A and forty-four contacts **412**A.

The housing **411**A includes a base **411A1**, a protrusion **411A2**, guide pin holes **411A3** for guide pins, holes **411A4** for floating screws, and holes **411A5**.

The base **411A1** is a base of the housing **411**A. The protruding part **411A2** has a shape like a flat plate and protrudes from the base **411A1**. The forty-four contacts **412**A are arranged on the surfaces of the protruding part **411A2**. Twenty two of the forty-four contacts **412**A are arranged on one surface of the protruding part **411A2**, and the remaining twenty-two contacts **412**A are arranged on the other surface of the protruding part **411A2**.

The protruding part **411A2** is provided separately from the base **411A1**, and is fitted into a through hole of the base **411A1**. The connector **410**A of FIGS. **8**A through **8**D is formed by fitting the protruding part **411A2** into the through hole of the base **411A1** after the contacts **412**A are attached to the surfaces of the protruding part **411A2**.

Each contact **412**A includes one signal line and two ground lines on the sides of the signal line that correspond to the signal line **125** and the ground lines **126** of the contact **120**A.

A first end of the contact **412**A extends up to an end of the protruding part **411A2** as illustrated by FIG. **8**A, and a second end of the contact **412**A extends in a direction opposite from the direction in which the protruding part **411A2** protrudes from the base **411A1** as illustrated by FIG. **8**D. The first end of the contact **412**A is connected to the signal line **125** and the ground lines **126** of the connector **100**A, and the second end of the contact **412**A is connected to the signal line and the ground lines of one of the FPCs **420**.

With the above configuration, the contact **412**A of the connector **410**A includes a coplanar line. The contact **412**A is configured as described above to achieve good impedance matching between the connector **100**A and the FPCs **420**, to reduce reflection and transmission loss of a signal, and to improve signal transmission characteristics.

The contact **412**A of the present embodiment is an SMT (surface mount technology) contact, and may be formed by mounting a patterned metal plate on the protruding part **411**A**2**.

The guide pin holes **411**A**3** receive the guide pins **112**A of the connector **100**A. The floating screw holes **411**A**4** receive screws for fastening the connector **100**A and the connector **410**A connected together as illustrated in FIG. **1**A. The holes **411**A**5** accept parts for fastening the FPCs **420** to the connector **410**A.

The above configuration of the connector **410**A also applies to the connector **410**B (see FIGS. **1**A and **1**B).

FIGS. **9**A and **9**B are drawings illustrating a mechanism for attaching the connector **410**A to the FPCs **420**. FIG. **9**A is a perspective view, and FIG. **9**B is an exploded view of FIG. **9**A.

On a side of the connector **410**A where the holes **411**A**5** are formed in the housing **411**A, the two sets of the twenty-two contacts **412**A are sandwiched between the two FPCs **420**. The FPCs **420** are fixed to the housing **411**A with a holder **415**, and screws **416** are inserted into through holes at the ends of the holder **415** and then into the holes **411**A**5** of the connector **410**A to attach the connector **410**A to first ends of the FPCs **420** as illustrated by FIG. **9**A. In this state, the signal lines and the ground lines formed on the two FPCs **420** are connected to the signal lines and the ground lines of the contacts **412**A of the connector **410**A.

The connector **410**B has substantially the same configuration as the connector **410**A, and can be attached to second ends of the FPCs **420** in a similar manner.

FIG. **10** is a perspective cut-away side view of the connector **100**A and the connector **410**A connected together. As described above, the connector **100**A includes two rows of twenty-two contacts **120**A arranged to face each other, and the connector **410**A includes two rows of twenty-two contacts **412**A arranged to face each other. The cross section of FIG. **10** illustrates two opposing contacts **120**A held in the housing **110**A of the connector **100**A, and two contacts **412**A on the opposite surfaces of the protruding part **411**A**2** of the housing **411**A of the connector **410**A.

As illustrated by FIG. **10**, the two contacts **412**A on the opposite surfaces of the protruding part **411**A**2** of the connector **410**A are sandwiched between the two contacts **120**A held in the housing **110**A of the connector **100**A.

In this state, the two contacts **120**A are pressed and caused to elastically bend by the two contacts **412**A on the opposite sides of the protruding part **411**A**2** in directions to increase the distance between the two contacts **120**A.

Also, the contacts **412**A of the connector **410**A are connected to the FPCs **420** on a side that is opposite from the side connected to the connector **100**A. The FPCs **420** are inserted between two opposing contacts **412**A. Accordingly, the two opposing contacts **412**A are connected to the FPCs **420** with their leaf spring structures pressed apart from each other.

Although the board **300**A (see FIG. **1**A) is omitted in FIG. **10**, the contacts **120**A of the connector **100**A are connected to the signal lines and the ground lines of the board **300**A. Using the connectors **100**A and **410**A makes it possible to connect the board **300**A and the FPCs **420** while achieving the impedance matching.

FIG. **11**A is a perspective view, FIG. **11**B is a front view, FIG. **11**C is a side view, and FIG. **11**D is a plan view of the connector **100**B. FIG. **12** is a perspective view of the connector **100**B attached to the board **300**B.

The connector **100**B includes a housing **110**B and contacts **120**B. The connector **100**B is formed by placing the contacts **120**B in a through hole **111**B of the housing **110**B. The housing **110**B includes guide pins **112**B used when the connector **410**B is attached to the connector **100**B. A bottom of each guide pin **112**B is embedded in the housing **100**B. The housing **110**B also includes screws **113**B and a slot **118**B. The slot **118**B communicates with the through hole **111**B in the housing **110**B, and receives the board **300**B.

Through holes corresponding to the screws **113**B are formed in the board **300**B. An end of the board **300**B is inserted into the slot **118**B of the housing **110**B, and the screws **113**B are screwed into the through holes of the board **300**B to attach the connector **100**B to the end of the board **300**B as illustrated by FIG. **1**A and FIG. **12**. For example, the guide pins **112**B may be comprised of a metal such as copper or nickel, or a resin.

The housing **110**B may be comprised of an insulating material such as an epoxy resin. The housing **110**B has a cuboid shape.

Each contact **120**B includes a first end and a second end, and has a configuration that is similar to a configuration obtained, for example, by housing the extension part **123**A of the contact **120**A (see FIG. **7**) in the housing **110**A. FIG. **11**C illustrates portions of the contacts **120**B to be connected to the board **300**B. The portions of the contacts **120**B are disposed to face each other and to contact the corresponding surfaces of the board **300**B in the slot **118**B. This configuration is similar to that of the contacts **120**A illustrated in FIG. **7**.

The first end of the contact **120**B is connected to the connector **410**B of the FPC assembly **400**, and the second end of the contact **120**B is connected to the signal line and the ground lines of the board **300**B.

FIG. **13** is a perspective cut-away side view of the connector **100**B and the connector **410**B connected to each other. The connector **100**B includes two rows of twenty-two contacts **120**B arranged to face each other, and the connector **410**B includes two rows of twenty-two contacts **412**B arranged to face each other. The cross section of FIG. **13** illustrates two opposing contacts **120**B held in the housing **110**B of the connector **100**B, and two contacts **412**B on the opposite surfaces of a protruding part **411**B**2** of a housing **411**B of the connector **410**B.

The configuration of the connector **410**B is substantially the same as the configuration of the connector **410**A illustrated by FIG. **8**A through **9**B. Therefore, components of the connector **410**B are indicated by reference numbers that are obtained by replacing "A" in the reference numbers of the corresponding components of the connector **410**A with "B".

Similarly to the contact **120**A (see FIG. **10**), the contact **120**B is held by a holder **114**B and is fitted into a gap between a partition wall **115**B in the housing **110**B and the inner wall of the housing **110**B.

The housing **110**B includes two engaging parts **116**B that are similar to the engaging parts **116**A of the housing **110**A.

When the contacts **120**B bound by the holder **114**B are inserted into the through hole **111**B and the holder **114**B is fitted into the gap between the inner wall of the housing **110**B and the partition wall **115**B, the first end of each contact **120**B engages with the corresponding engaging part **116**B.

The housing **110**B also includes lids **117**B on the side of the slot **118**B of the through hole **111**B. Each of the lids **117**B includes an engaging part **117**B**1**. The engaging parts **117**B**1** are located inside of the slit **118**B and have a configuration similar to that of the engaging parts **116**B.

When the contacts **120**B bound by the holder **114**B are inserted into the through hole **111**B and the holder **114**B is fitted into the gap between the inner wall of the housing **110**B and the partition wall **115**B, the second end of each contact **120**B engages with the corresponding engaging part **117**B**1**.

The lids **117**B are removed from the housing **110**B when the two sets of the contacts **120**B bound by the holder **114**B are inserted into the through hole **111**B of the housing **110**B, and are attached to the housing **110**B after the two sets of the contacts **120**B are inserted into the through hole **111**B. When the lids **117**B are attached, the second ends of the contacts **120**B engage with the engaging parts **117**B**1**.

With the first end of the contact **120**B engaging with the engaging part **116**B, the second end of the contact **120**B engaging with the engaging part **117**B**1**, and the holder **114**B holding the base **121**B fitted into the gap between the inner wall of the housing **110**B and the partition wall **115**B, the contact **120**B can function as a leaf spring.

As illustrated by FIG. **13**, the two contacts **412**B on the opposite surfaces of the protruding part **411**B**2** of the connector **410**B are sandwiched between the two contacts **120**B held in the housing **110**B of the connector **100**B.

In this state, the two contacts **120**B are pressed and caused to elastically bend by the two contacts **412**B on the opposite sides of the protruding part **411132** in directions to increase the distance between the two contacts **120**B.

Also, the contacts **412**B of the connector **410**B are connected to the FPCs **420** on a side that is opposite from the side connected to the connector **100**B. The FPCs **420** are inserted between two opposing contacts **412**B. Accordingly, the two opposing contacts **412**B are connected to the FPCs **420** with their leaf spring structures pressed apart from each other.

Although the board **300**B (see FIG. **12**) is omitted in FIG. **13**, the contacts **120**B of the connector **100**B are connected to the signal lines and the ground lines of the board **300**B. Using the connectors **100**B and **410**B makes it possible to connect the board **300**B and the FPCs **420** while achieving the impedance matching.

As described above, by using the connector **100**A including the contacts **120**A and the connector **100**B including the contacts **120**B of the present embodiment, it is possible to connect the connector **100**A and the connector **410**A and connect the connector **100**B and the connector **410**B while achieving the impedance matching.

That is, the present embodiment makes it possible to connect the board **300**A and the FPCs **420** and connect the board **300** and the FPCs **420** while achieving the impedance matching.

An aspect of this disclosure provides the connectors **100**A and **100**B and the contacts **120**A and **120**B that make it possible to transmit a signal in an impedance matched condition.

Connectors and contacts according to embodiments of the present invention are described above. However, the present invention is not limited to the specifically disclosed embodiments, and variations and modifications may be made without departing from the scope of the present invention.

What is claimed is:

1. A connector to be connected to a signal wire and a ground wire formed on a board, the connector comprising:

a housing to be attached to the board;

a ground terminal including

a base that is disposed in the housing,

three first extension parts that extend from the base toward a first end of the housing, including a first middle extension part, and first side extension parts each of which is provided on a side of the first middle extension part, respectively, and

three second extension parts that extend from the base toward a second end of the housing, including a second middle extension part, and second side extension parts each of which is provided on a side of the second middle extension part, respectively, the second extension parts being configured to contact a surface of the board and to be elastically bent when the housing is attached to the board;

an insulating layer formed on a surface of the ground terminal;

a signal line that is formed on the insulating layer and extends from an end of the first middle extension part to an end of the second middle extension part, the signal line is connected to the signal wire of the board when the housing is attached to the board; and

ground lines that are formed on the insulating layer, are electrically connected to the ground terminal, and each extends from an end of one of the first side extension parts to an end of one of the second side extension parts, each of the ground lines is connected to the ground wire of the board when the housing is attached to the board.

2. The connector as claimed in claim **1**, wherein the first extension parts are configured such that when another connector is connected to the connector, the signal line and the ground lines formed on the first extension parts are connected to a signal wire and a ground wire of the other connector, respectively.

3. The connector as claimed in claim **1**, wherein the signal line is implemented by a first plated layer formed on the insulating layer.

4. The connector as claimed in claim **1**, wherein

each of the ground lines is implemented by a second plated layer formed on the insulating layer; and

the second plated layer is connected to the ground terminal via a groove that passes through the insulating layer in a thickness direction.

5. The connector as claimed in claim **1**, wherein

the connector comprises a plurality of ground terminals; and

the connector further comprises a holder that holds the ground terminals to bind the ground terminals together.

6. A contact to be connected to a signal wire and a pair of ground wires formed on a board, the contact comprising:

a ground terminal including

a base that includes a first end and a second end,

three first extension parts that extend from the first end of the base and include a first middle extension part and first side extension parts on sides of the first middle extension part, and

three second extension parts that extend from the second end of the base and include a second middle extension part and second side extension parts on sides of the second middle extension part, the second extension parts being configured to contact a surface of the board and to be elastically bent when the contact is connected to the board;

an insulating layer formed on a surface of the ground terminal;

a signal line that is formed on the insulating layer and extends from an end of the first middle extension part to an end of the second middle extension part, wherein when the contact is connected to the board, the signal line on the second middle extension part is connected to the signal wire of the board and the second extension parts are elastically bent; and

a pair of ground lines that are formed on the insulating layer, are connected to the ground terminal, and extend from ends of the first side extension parts to ends of the second side extension parts, wherein when the contact is connected to the board, the ground lines on the second

side extension parts are connected to the ground wires of the board and the second extension parts are elastically bent.

7. A connector to be connected to a signal wire and a ground wire formed on a board, the connector comprising:

a terminal including

a base made of a conductive material,

at least two first extension parts that extend from the base toward a first end of the connector, and

at least two second extension parts that extend from the base toward a second end of the connector;

an insulating layer formed on a surface of the terminal;

a signal line that is formed on the insulating layer, is insulated from the terminal, and extends from an end of a first one of the first extension parts to an end of a first one of the second extension parts, the signal line being connected to the signal wire of the board when the connector is attached to the board; and

a ground line that is formed on the insulating layer, is electrically connected to the terminal, and extends from an end of a second one of the first extension parts, which is adjacent to the first one of the first extension parts, to an end of a second one of the second extension parts, which is adjacent to the first one of the second extension parts, the ground line being connected to the ground wire of the board when the connector is attached to the board.

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